

## REMARKS

Reconsideration and allowance of the subject application are respectfully solicited.

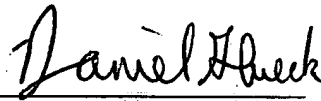
Claims 1 through 6, 9 through 12, 14, 20 through 22, 24, 27, and 44 are pending, with Claims 1, 2, 3, and 27 being independent. Claims 7, 8, 13, 15 through 19, 23, 25, 26, 28 through 43 and 45 through 68 have been cancelled without prejudice. Claims 4 through 6, 20, 21, and 44 have been amended. The specification has been amended.

In response to the Election of Species Requirement set forth in the Official Action, Applicants provisionally elect Species (II) with traverse, and respectfully submit that all claims (i.e., Claims 1 through 6, 9 through 12, 14, 20 through 22, 24, 27, and 44) are readable thereupon, with Claims 1, 2, 4 through 6, 9 through 12, 14, 20 through 22, 24, 27, and 44 being generic. In this regard, Applicants wish to thank the Examiner for the courtesies extended during a telephonic conversation on July 26, 2002, from which conversation Applicants understand that Species (I) was intended by the Official Action to be directed to the use of mirrors as in Fig. 21, with Species (II) being intended to be directed to a transparent solid body. However, the Election of Species Requirement respectfully is traversed. Neither Applicants nor the Patent and Trademark Office should be put through the trouble and expense entailed in multiple filing and prosecution. Further, the making of an Election of Species Requirement is not mandatory in all instances. It is submitted that it would not be an undue burden on the Examiner to examine all of the pending claims in the present application. Accordingly, in the interests of prosecution and economy of time, for Applicants, the Office, and the public-at-large, reconsideration and withdrawal of the Election of Species Requirement is respectfully requested.

Applicants submit that this application is in condition for allowance, and a Notice of Allowance is respectfully requested.

Applicants' undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our address listed below.

Respectfully submitted,



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**VERSION SHOWING CHANGES MADE TO THE SPECIFICATION**

Please substitute the following paragraph for the paragraph starting at page 4, line 5 and ending at line 19.

This optical system is called an off-axial, optical system because the optical system includes a surface in which at an intersecting point between the reference axis corresponding to the optic axis and the component surface the reference axis does not agree with the normal to the surface but makes a finite angle [except for] other than 0 therewith (the definition of the off-axial, optical system). Surfaces of this type are called off-axial surfaces or off-axial curved surfaces. In this case, the imaging optical system 5 is also composed of a front element 10 (the surfaces 10-1, 10-2) composing the object-side imaging element and a rear element 11 (the surfaces 11-1, 11-2, 11-3, 11-4) composing the image-side imaging element, the elements 10, 11 being incorporated.



Please substitute the following paragraph for the paragraph starting at page 33, line 22 and ending at page 34, line 10.

Fig. 1A is a sectional view of major part of an embodiment of an optical system according to the present invention, also illustrating optical paths. Fig. 1B [is] are spot diagrams in the optical paths of Fig. 1A. Numeral 1 designates the object plane. Numeral 5 represents an optical element in which a plurality of reflective surfaces having respective curvatures (curved

surfaces) are integrally formed, which composes an element of the imaging optical system. The optical element 5 has an entrance refractive surface 10-1, four reflective surfaces including mirror 10-2, mirror 10-3, mirror 11-1, and mirror 11-2, and an exit refractive surface 11-3 formed in order along the reference-axis ray from the object side in the surface of a transparent body (optical material), thus forming a non-coaxial, off-axial, optical system.

Please substitute the following paragraph for the paragraph starting at page 40, line 3 and ending at line 15.

When the object-side imaging element 10 and the image-side imaging element 11 each include the astigmatism independent of the field angle (the on-axis astigmatism) as described above, even if there is a noise source such as the dust, bubble, or flaw near the intermediate image plane 2 (at or near the plane 2), the on-axis astigmatism prevents the noise source from eclipsing [the all] all image information from the object points on the object plane 1; and the noise source is not imaged as a point on the final image plane 3 but is blurred by the on-axis astigmatism, thus flattening the (disturbance of) light intensity distribution on the image plane due to the noise source.

Please substitute the following paragraph for the paragraph starting at page 40, line 16 and ending at page 41, line 26.

In general the size of the spot near the intermediate image plane 2 due to the on-axis astigmatism deliberately generated on the intermediate image plane 2 differs depending upon tolerance specifications of noise caused by the noise source, but it is two or more times,

preferably three or more times, the size of the noise source posing the problem even at the minimum aperture value (which relates to the resolution of the image pickup device and which is given approximately by (Eq 1) described previously); in that case, since it is roughly estimated that an amount of light eclipsed by the noise source is proportional to approximately the square of a ratio of diameters, the amount of eclipsed light is not more than 25 % (which is a closely permissible level though the effect is recognized, from the empirical aspect), desirably not more than 11 % (which is a level in which the effect can be recognized first with attention, from the empirical aspect), thereby achieving the effect of flattening the disturbance of light intensity distribution on the image plane due to the noise source at [the all] all aperture values. This means that for the minimum resolution  $b$  given by the size of the pixels of the image pickup device or the like, when  $\beta_{11}$  represents the image magnification of the image-side imaging element 11 in the case where the intermediate image plane 2 is imaged on the final image plane 3 on which the image pickup device is located, the size of the spot, which is two or more times, desirably three or more times, ((Eq 1) described previously), is defined to be not less than the following:

$$10 \cdot b / |\beta_{11}| \quad (\text{Eq 2});$$

desirably, not less than the following:

$$15 \cdot b / |\beta_{11}| \quad (\text{Eq 3});$$

whereby the effect of flattening the disturbance of light intensity distribution on the image plane due to the noise source can be achieved at [the all] all aperture values.

Please substitute the following paragraph for the paragraph starting at page 49, line 11 and ending at page 50, line 4.

In general the size of the spot near the intermediate image plane due to the "aberration of torsion" deliberately generated on the intermediate image plane differs depending upon tolerance specifications of noise caused by the noise source; however, if the spot size is two or more times, preferably three or more times, the size of the noise source posing the problem at the minimum aperture value (which relates to the resolution of the image pickup device and which is given approximately by (Eq 1) described previously), it is roughly estimated that the amount of light eclipsed by the noise source is not more than 25 % (which is a closely permissible level though the effect is recognized, from the empirical aspect), desirably not more than 11 % (which is a level in which the effect can be recognized first with attention, from the empirical aspect), as in Embodiment 1, thereby achieving the effect of flattening the disturbance of light intensity distribution on the image plane due to the noise source at [the] all aperture values.

Please substitute the following paragraph for the paragraph starting at page 50, line 5 and ending at line 21. A marked-up copy of this paragraph, showing the changes made thereto is attached.

This means that for the minimum resolution  $b$  given by the size of the pixels of the image pickup device or the like, when  $\beta_{11}$  represents the image magnification of the image-side imaging element 11 in the case where the intermediate image plane 2 is imaged on the final image plane 3 on which the image pickup device is located, the size of the spot, which is

two or more times, desirably three or more times, ((Eq 1) described previously), is defined to be not less than the following:

$$10 \cdot b / |\beta_{11}| \quad (\text{Eq 2});$$

desirably, not less than the following:

$$15 \cdot b / |\beta_{11}| \quad (\text{Eq 3});$$

whereby the effect of flattening the disturbance of light intensity distribution on the image plane due to the noise source can be achieved at [the] all aperture values.

Please substitute the following paragraph for the paragraph starting at page 53, line 19 and ending at page 54, line 2.

Figs. 4A, 4B, and 4C are conceptual drawings of a major part of Embodiment 3 of the optical system according to the present invention. In this embodiment, the optical system involving the intermediate imaging is not a single lens but a zoom optical system. The zoom optical system as an off-axial, optical system corresponding to this embodiment is disclosed in Japanese Patent Application Laid-open No. 8-292372, wherein the image on the object plane 1 is formed by intermediate imaging and the intermediate image is imaged on the final image plane.

Please substitute the following paragraph for the paragraph starting at page 75, line 11 and ending at page 76, line 1.

In Fig. 9 reference numeral 20 designates an optical element having a plurality of curved, reflective surfaces, which is made of a transparent body such as glass. In the surface of the optical element 20 there are a concave, refractive surface (entrance surface) R2 having a

negative refractive power, five reflective surfaces of concave mirror R3, convex mirror R4, concave mirror R5, reflective surface R6, and concave mirror R7, and a convex, refractive surface (exit surface) R8 having a positive refractive power, formed in the order of passage of rays from the object. R1 represents the stop located on the object side of the optical element 20 and R9 the final image plane, on which the image pickup surface of the image pickup device such as CCD is located. The two refractive surfaces are rotationally symmetric, spherical surfaces, and [the all] all reflective surfaces are surfaces symmetric only with respect to the YZ plane.

Please substitute the following paragraph for the paragraph starting at page 81, line 7 and ending at line 24.

In Fig. 11 reference numeral 20 designates an optical element having a plurality of curved, reflective surfaces, which is made of a transparent body such as glass. In the surface of the optical element 20 there are a concave, refractive surface (entrance surface) R2 having a negative refractive power, five reflective surfaces of concave mirror R3, convex mirror R4, concave mirror R5, reflective surface R6, and concave mirror R7, and a convex, refractive surface (exit surface) R8 having a positive refractive power, formed in the order of passage of rays from the object. R1 represents the stop located on the object side of the optical element 20 and R9 the final image plane, on which the image pickup surface of the image pickup device such as CCD is located. The two refractive surfaces are rotationally symmetric, spherical surfaces, and [the all] all reflective surfaces are surfaces symmetric only with respect to the YZ plane.



Please substitute the following paragraph for the paragraph starting at page 86, line 13 and ending at page 87, line 3.

In Fig. 13 reference numeral 20 designates an optical element having a plurality of curved, reflective surfaces, which is made of a transparent body such as glass. In the surface of the optical element 20 there are a concave, refractive surface (entrance surface) R2 having a negative refractive power, five reflective surfaces of concave mirror R3, convex mirror R4, concave mirror R5, reflective surface R6, and concave mirror R7, and a convex, refractive surface (exit surface) R8 having a positive refractive power, formed in the order of passage of rays from the object. R1 represents the stop located on the object side of the optical element 20 and R9 the final image plane, on which the image pickup surface of the image pickup device such as CCD is located. The exit surface is a rotationally symmetric, spherical surface, and [the all] all reflective surfaces are surfaces symmetric only with respect to the YZ plane.

Please substitute the following paragraph for the paragraph starting at page 91, line 15 and ending at page 92, line 5.

In Fig. 15 reference numeral 20 designates an optical element having a plurality of curved, reflective surfaces, which is made of a transparent body such as glass. In the surface of the optical element 20 there are a concave, refractive surface (entrance surface) R2 having a negative refractive power, five reflective surfaces of concave mirror R3, convex mirror R4, concave mirror R5, reflective surface R6, and concave mirror R7, and a convex, refractive surface (exit surface) R8 having a positive refractive power, formed in the order of passage of rays from the object. R1 represents the stop located on the object side of the optical element 20

and R9 the final image plane, on which the image pickup surface of the image pickup device such as CCD is located. [The all] All reflective surfaces are surfaces symmetric only with respect to the YZ plane.

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**MARKED-UP CLAIM SHEET**

1. (Amended) An optical element comprising:

an object-side imaging element for imaging an object on an intermediate image plane in an optical path; and

an image-side imaging element for reimaging an object image formed on the intermediate image plane, on a final image plane,

wherein at least one of said object-side imaging element and said image-side imaging element comprises an off-axial curved surface, and

wherein aberration is generated by both of the object-side imaging element and the image-side imaging element, so as to flatten [(disturbance of)] a light intensity distribution on the final image plane, caused by a noise source at or near the intermediate image plane.

4. (Amended) An optical element according to Claim 1, [2, or 3,] wherein

said aberration is generated so as to degrade imaging performance of said object-side imaging element and so as to correct the imaging performance thus degraded, by said image-side element.

5. (Amended) An optical element according to Claim 1, [2 or 3,] wherein said off-axial curved surface is provided in at least one reflective surface out of said plurality of reflective surfaces.

6. (Twice Amended) An optical element according to Claim 1 [any one of Claims 1 to 3], wherein said optical element has a stop, and wherein the following relation is satisfied:

$$V/|\beta_{11}| < U$$

where  $\beta_{11}$  is an image magnification of said image-side imaging element, V a spot size on the final image plane at a fixed aperture diameter of said stop, and U a spot size on said intermediate image plane.

20. (Twice Amended) An optical apparatus wherein said object is imaged on a photoreceptive surface of an image pickup device by use of the optical element as set forth in Claim 1 [any one of Claims 1 to 3].

21. (Twice Amended) An optical apparatus comprising at least two optical elements as set forth in Claim 20 [any one of Claims 1 to 3], wherein relative positions are changed between said at least two optical elements, whereby the object is imaged at different magnifications on an image pickup device.

27. (Amended) An optical system comprising:

an object-side imaging element for once imaging an object on an intermediate image plane in an optical path; and

an image-side imaging element for reimaging an object image formed on the intermediate image plane, on a final image plane,

wherein at least one of said object-side imaging element and said image-side imaging element comprises an off-axial curved surface, and

wherein aberration is generated by both of the object-side imaging element and the image-side imaging element, so as to flatten [of] a light intensity distribution on the final image plane, caused by a noise source at or near the intermediate image plane.

44. (Twice Amended) An optical apparatus wherein said object is imaged on a photoreceptive surface of an image pickup device by use of the optical system as set forth in Claim 27 [either one of Claims 27 to 28].